A photograph of a remote water quality monitoring station. A solar panel is mounted on a metal pole, angled towards the sun. Below the panel is a green metal control box with a lock and a small label. The station is located on a grassy bank next to a river. In the background, there are trees with autumn foliage and a cloudy sky.

Remote Water Quality Monitoring Network in the Susquehanna River Basin

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Susquehanna River Basin Commission

National Monitoring Conference

May 1, 2014

Susquehanna River Basin



The Basin

- 27,510-square-mile watershed
- Comprises 43% of the Chesapeake Bay Watershed
- 60% forested
- 32,000+ miles of waterways

The Susquehanna River

- 444 miles, largest tributary to the Chesapeake Bay
- Supplies 18 million gallons a minute to the bay
- Longest river in the continental US without commercial boat traffic

Remote Water Quality Monitoring Network Objectives

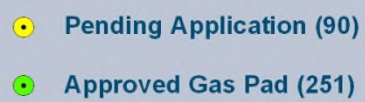
Establishing a real-time water quality monitoring network within areas of concern in the Susquehanna River Basin

- Establish baseline water quality conditions;
- Determine if the natural gas well industry and/or other activities are causing adverse impacts on local water quality;
- Form collaborative partnerships to improve monitoring technology and provide educational opportunities;
- Enhance protection for water supplies; and
- Be responsive to public concerns.

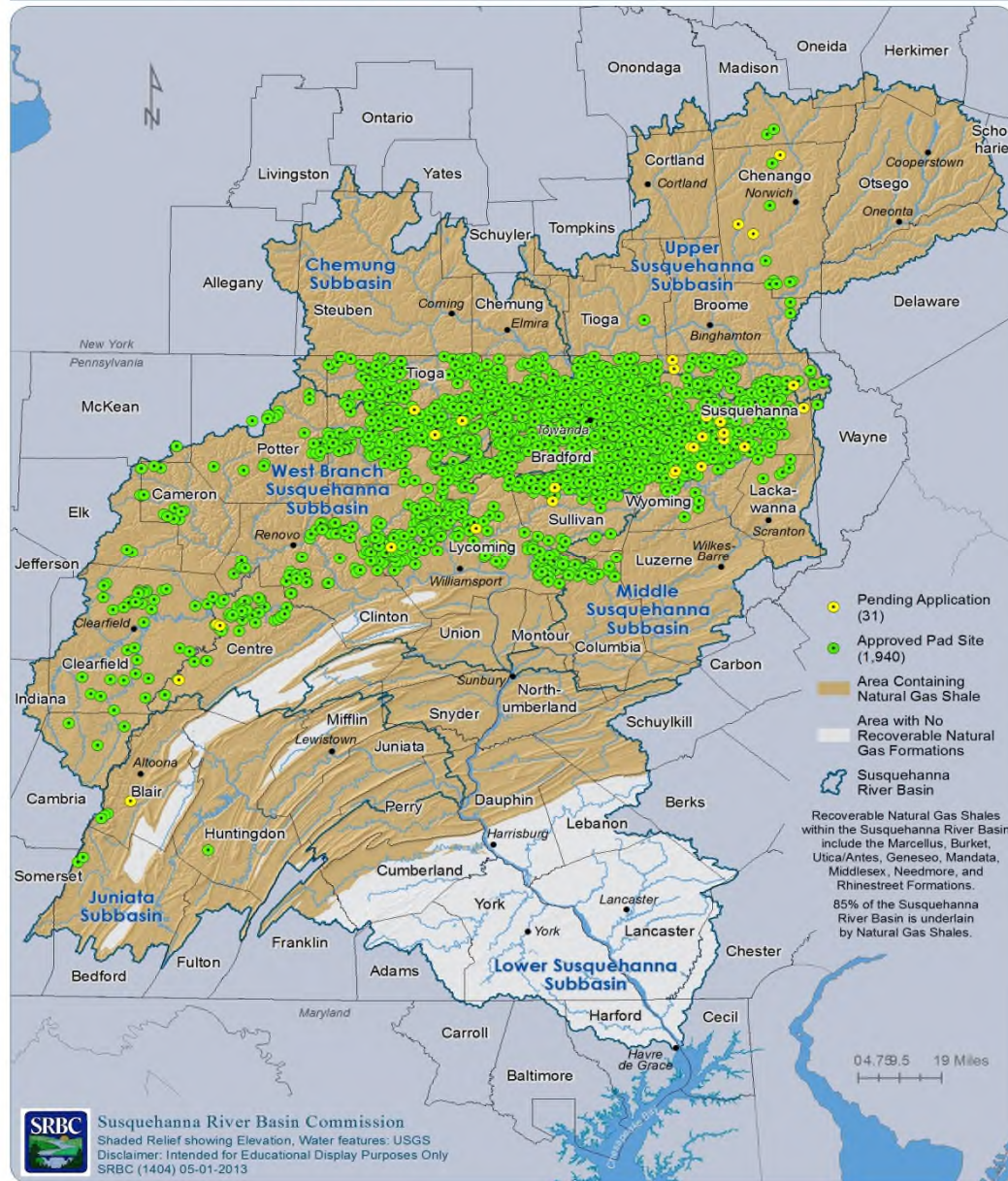
Remote Water Quality Monitoring Network – Timeframe

- First monitoring stations deployed – 2010
- Macroinvertebrate sampling – 2011
- Fish sampling – 2012
- Rain gauges – 2013
- Pressure transducers for rating curve development - 2013

under 18CFR§806.22(f) in the
Susquehanna River Basin,
November 16, 2009



APPROVAL BY RULE (ABR) FOR NATURAL GAS PAD LOCATIONS
under 18CFR§806.22(f) in the Susquehanna River Basin, May 1, 2013

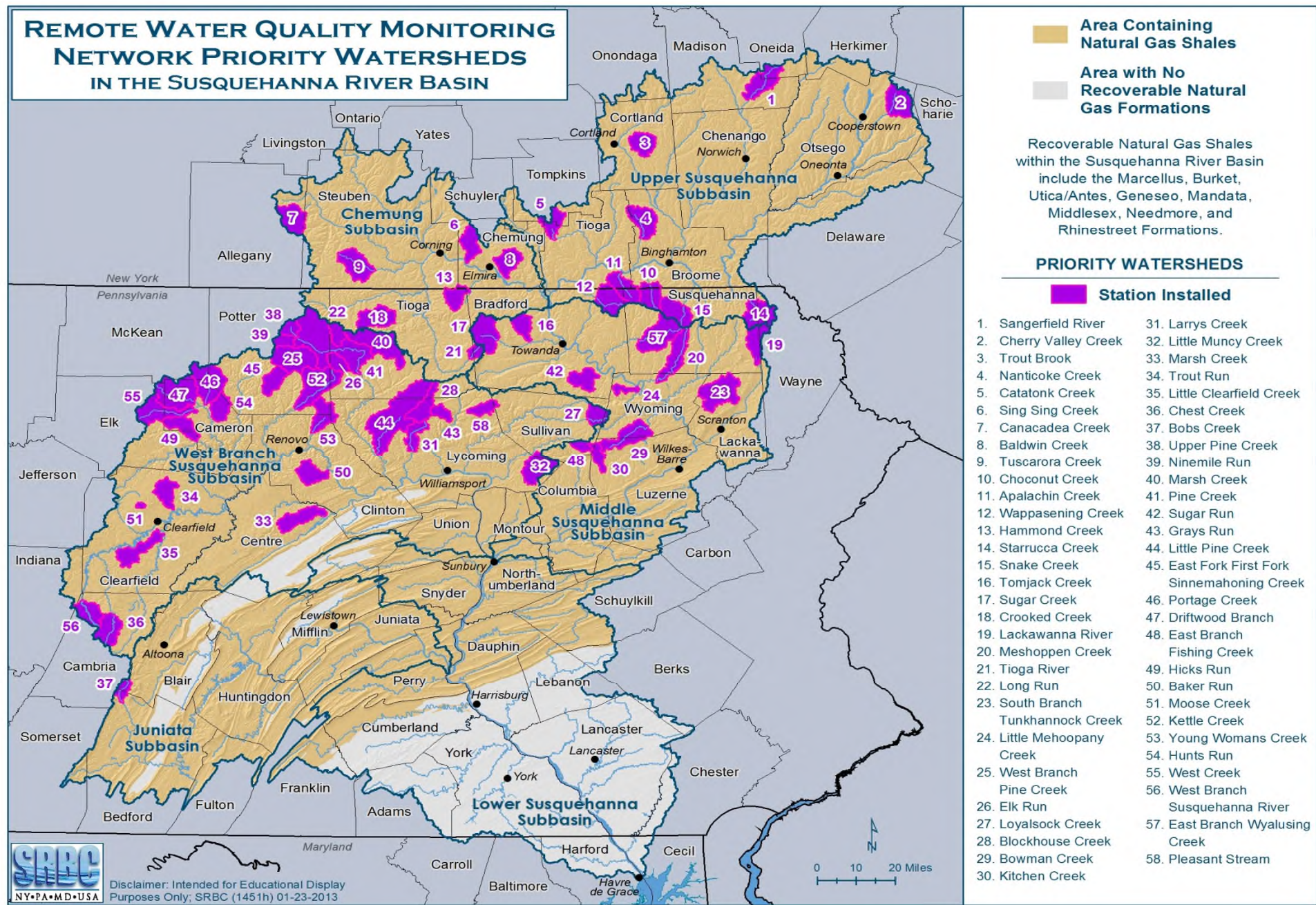


Network Design - Watershed Selection

- Watershed size - 30-60 square miles
- Areas associated with or with potential natural gas development
- Sensitive and high quality headwater areas
(Aquatic life, recreation, public water supply)
- Site conditions
(channel morphology, seasonal conditions, etc.)
- Land use
- Property access/agreements



REMOTE WATER QUALITY MONITORING NETWORK PRIORITY WATERSHEDS IN THE SUSQUEHANNA RIVER BASIN



Equipment

- Data sonde
 - YSI 6600 V2-4 data sonde
- Data platform
 - NexSens 3100 or 6100 iSIC unit
- Power source
 - Solar panel – most common





Continuous Parameters

- Dissolved Oxygen
- Temperature
- pH
- Conductance
- Turbidity
- Collected at 5-minute intervals
- Transmitted to a public web site at 2-4 hour intervals
- Posted as provisional data
- “Alarms” sent via email to alert staff of potential problems or sonde malfunctions

<u>Monitoring Station</u>	<u>Temperature (C)</u>	<u>Specific Conductivity (mS/cm)</u>	<u>pH</u>	<u>Turbidity (NTU+)</u>	<u>ODO (mg/L)</u>
Apalachin Creek (4/16/2014 9:55:00 AM)	3.85	0.107	7.38	42	13.57
Baldwin Creek (4/16/2014 10:10:00 AM)	3.33	0.136	7.15	24.2	13.28
Blockhouse Creek (4/16/2014 10:10:00 AM)	3.74	0.094	7.29	5.8	13.76
Bobs Creek (4/16/2014 8:00:00 AM)	2.98	0.078	6.51	2.94	13.1
Bowman Creek (4/16/2014 10:10:00 AM)	3.78	0.032	5.77	28.2	13.39

Operation & Maintenance

- Data Sonde
 - Site visit every 6-8 weeks
 - Sonde is calibrated before deployment and post calibrated after deployment
 - Annual maintenance
- Data
 - Corrected for fouling and probe drift – Aquarius software
 - Provisional and corrected data are posted on SRBC's web site
 - Data reports

Data Analysis - Level 3 Ecoregions

- North Central Appalachian
 - 24 stations
- Northern Appalachian Plateau and Uplands
 - 21 stations
- Central Appalachian Ridges and Valleys
 - 5 stations

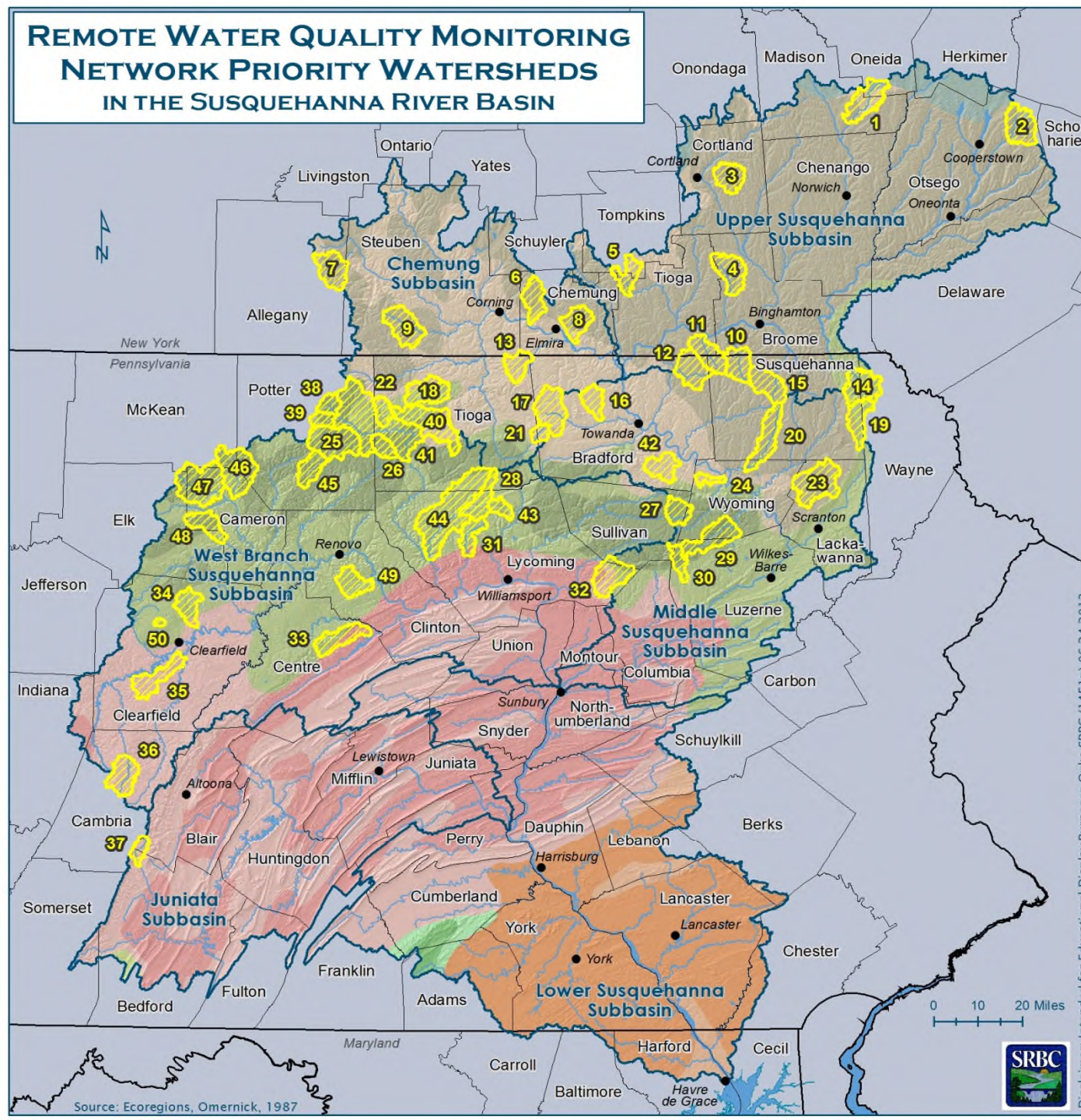
REMOTE WATER QUALITY MONITORING NETWORK PRIORITY WATERSHEDS IN THE SUSQUEHANNA RIVER BASIN

ECOREGIONS

-  Northern Appalachian Plateau and Uplands
-  Erie/Ontario Lake Plain
-  North Central Appalachians
-  Northern Piedmont
-  Blue Ridge Mountains
-  Central Appalachian Ridges and Valleys
-  Central Appalachians

PRIORITY WATERSHEDS

- | | |
|------------------------------------|--|
| 1. Sangerfield River | 26. Elk Run |
| 2. Cherry Valley Creek | 27. Loyalsock Creek |
| 3. Trout Brook | 28. Blockhouse Creek |
| 4. Nanticoke Creek | 29. Bowman Creek |
| 5. Catatunk Creek | 30. Kitchen Creek |
| 6. Sing Sing Creek | 31. Larrys Creek |
| 7. Canacadea Creek | 32. Little Muncy Creek |
| 8. Baldwin Creek | 33. Marsh Creek |
| 9. Tuscarora Creek | 34. Trout Run |
| 10. Choconut Creek | 35. Little Clearfield Creek |
| 11. Apalachin Creek | 36. Chest Creek |
| 12. Wappasening Creek | 37. Bobs Creek |
| 13. Hammond Creek | 38. Upper Pine Creek |
| 14. Starrucca Creek | 39. Ninemile Run |
| 15. Snake Creek | 40. Marsh Creek |
| 16. Tomjack Creek | 41. Pine Creek |
| 17. Sugar Creek | 42. Sugar Run |
| 18. Crooked Creek | 43. Grays Run |
| 19. Lackawanna River | 44. Little Pine Creek |
| 20. Meshoppen Creek | 45. East Fork First Fork Sinnemahoning Creek |
| 21. Tioga River | 46. Portage Creek |
| 22. Long Run | 47. Driftwood Branch |
| 23. South Branch Tunkhannock Creek | 48. Hicks Run |
| 24. Little Mehoopany Creek | 49. Baker Run |
| 25. West Branch Pine Creek | 50. Moose Creek |



Disclaimer: Intended for Educational Display Purposes Only. SRBC (1451)n 06-24-2013



North Central Appalachian

- Smallest variability of specific conductance, DO, and turbidity
- Lowest values of specific conductance, turbidity, and pH
- Highest DO concentrations



Northern Appalachian Plateau and Uplands

- More variability seen in conductance and turbidity
 - Stations with highly mobile substrate showed higher conductance and turbidity values
- DO concentration only slightly lower than North Central Appalachian ecoregion



Central Appalachian Ridges and Valleys

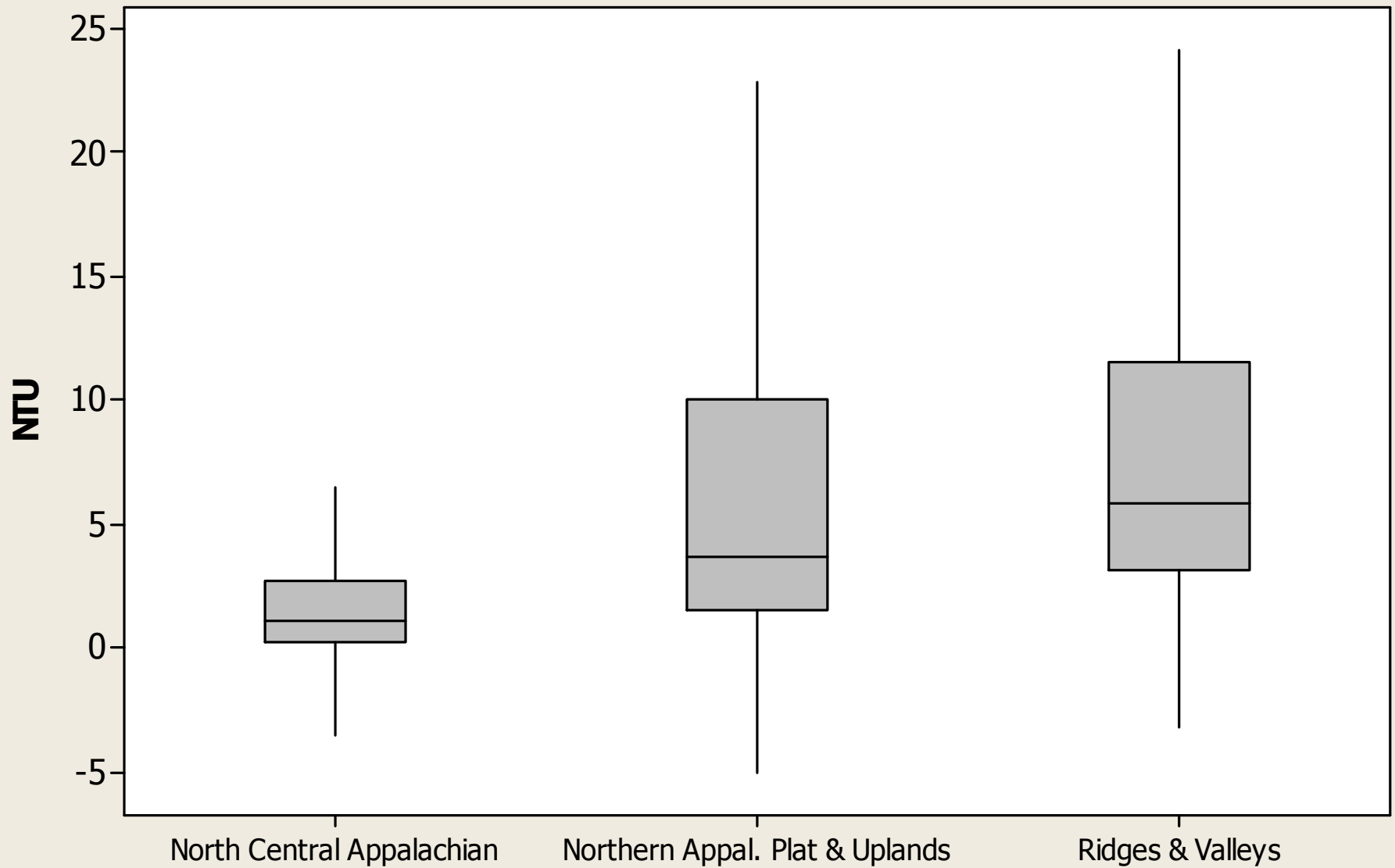
- Large variability in conductance and turbidity
 - Small sample size
 - Two stations impacted by mine drainage
- Lowest average DO



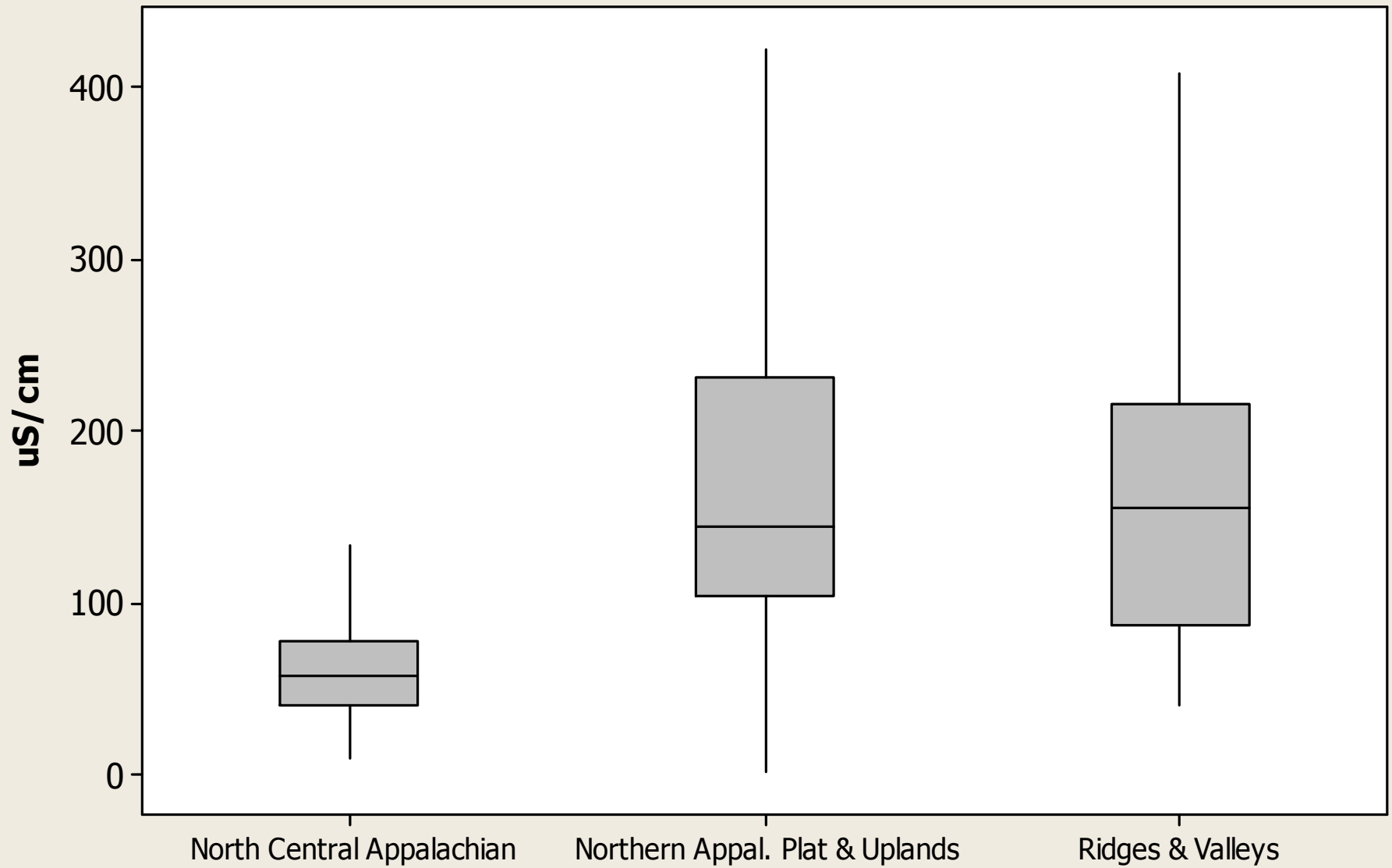
Conductance and Turbidity

- Main two continuous parameters of concern related to fracking
- Turbidity – related activities
 - New roads
 - Pad construction
 - Pipelines
- Conductance – frack flowback/wastewater have very high conductance

Turbidity



Specific Conductance



Specific Conductance Correlations

Parameters: watershed size, land use, geology, well density, and dischargers

Watershed	Size (mi2)	% Forested	Glacial Geology	Well Density (#/mi2)	WWTP	Specific Conductance
Canacadea Creek	47	70	Yes	0.00	1	422
Little Clearfield Creek*	44	74	No	0.02	2	397
Sing Sing Creek	35	60	Yes	0.00	0	378
Catatonk Creek	30	70	Yes	0.00	0	294
Larrys Creek	29	76	No	0.97	0	59
Trout Run	33	91	No	0.55	0	55
Tioga River	13	85	No	0.85	0	44
Baker Run	35	99	No	0.29	0	24

* AMD impacted

Supplemental Sampling

- Discharge
- Lab water chemistry
- Macroinvertebrates
- Habitat
- Fish



Acidity	Chloride
Alkalinity	Bromide
Carbonate Alkalinity	Carbon Dioxide
Bicarbonate Alkalinity	Total Dissolved Solids
Barium	Total Organic Carbon
Aluminum	Sulfate
Calcium	pH
Magnesium	Specific Conductance
Sodium	Nitrate
Potassium	Phosphorus
Strontium	Gross Alpha
Lithium	Gross Beta
Iron	Magnesium

Water Chemistry Sampling

- Seasonal grab samples
- Overall, parameters are well below water quality standards
 - Elevated nutrient levels seen in agricultural dominated watersheds
 - Elevated metal concentrations seen in mining watersheds
- Bromide
 - $\leq 50 \mu\text{g/l}$ – normal freshwater levels
 - September 2012 sampling round – 8 stations recorded concentrations over $50 \mu\text{g/l}$
 - Very low flows
 - January and April 2013 – concentrations returned back to normal conditions

Macroinvertebrate Data

	PINE CREEK WATERSHED									
	Upper Pine	Ninemile	Pine	Little Pine	Elk	Long	West Pine	Blockhouse		Baker
PERCENT FORESTED	75	85	80	83	82	81	86	75		99
DRAINAGE AREA SQM	19	16	385	180	21	21	70	38		35
TOTAL INDIVIDUALS	229	261	223	228	224	242	234	181		210
TOTAL TAXA	40	40	28	27	38	36	42	30		44
PA IBI METRICS										
Taxa Richness	40	40	28	27	38	36	42	30		44
EPT Taxa (PTV 0-4)	32	28	20	16	24	23	28	21		26
Beck's Index	42	38	23	14	33	37	40	31		43
Hilsenhoff Biotic Index	2.65	2.68	3.18	3.39	2.93	2.62	2.84	2.58		3.35
Shannon Diversity	3.27	2.60	2.82	1.80	3.11	2.90	3.21	2.68		3.19
Percent Sensitive (PTV 0-3)	64.19	67.43	56.95	71.49	62.05	65.29	62.39	67.40		46.67
IBI SCORE (small)	96.19	93.51			91.24	94.27		89.56		89.53
IBI SCORE (large)			95.39	84.83			98.92			

- Pine Creek Watershed – scenic, recreational river
- Baker Run – drilling is the only activity in the watershed

Future Direction of the Project

- Continue real-time monitoring at the 58 stations
 - Installation of 2 additional stations in 2014
- Continue supplemental sampling
- Auto-samplers – set to collect water samples based on continuous data triggers
- Turbidity duration curves
- Turbidity and conductance correlations with precipitation and flow
- Trends analyses

Real-Time Rain Gauge and Water Depth Data

- Rain gauges
 - Real-time - 8 stations
 - Stored on-site - 3 stations
- Pressure transducers
 - Real-time - 12 stations
 - Stored on-site - 4 stations
- Data are transmitted to an in-house database, but are not available to the public



**RM Young Tipping
Bucket Rain Gauge**



**OTT Pluvio2
Precipitation Gauge**

Trends Analyses

- Choconut, Hammond, and Meshoppen Creeks
 - Three years of continuous data
 - Same ecoregion
 - Difference in drilling activity
- Choconut Creek
 - Conductance – decreasing trend
 - Turbidity – decreasing trend
- Hammond Creek
 - Temperature – increasing trend
 - pH – increasing trend

Questions

<http://mdw.srbc.net/remotewaterquality/>

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Special Thanks

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